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EXPERIMENTS IN CROP PRODUCTION ON FALLOW LAND AT SAN ANTONIO.[1]

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INTRODUCTION.

The practice of fallowing land varies widely in different regions. In the experiments conducted at San Antonio, Tex., and reported in this paper the word "fallow" is used to mean thorough cultivation of the land from the time it is plowed after the removal of a crop throughout the next season and until the crop is planted at the beginning of the second season. The fallow period at San Antonio varies from 16 to 19 months, depending on the crops grown. The chief ostensible purpose of fallowing in this region is to store in the soil for the benefit of the next crop the moisture which falls during the fallow period.

In order to determine whether or not this practice is to be recommended in the San Antonio region, the experiments reported herein were started in 1910.

CLIMATIC CONDITIONS.

The climatic conditions at San Antonio are much different from those in the dry-farming regions farther north.

The conditions fluctuate irregularly from semiarid to humid. Droughts of many weeks' duration are common and may come at almost any season of the year, but they are more frequent and more serious during the summer months. The mean annual rainfall at San Antonio for a period of 33 years, as reported by the United States Weather Bureau, is 26.83 inches. The mean annual rainfall for the 7-year period from 1907 to 1913, inclusive, as measured at the San Antonio Experiment Farm, 5 miles south of the city, is 24.66 inches. While the normal precipitation would appear to be sufficiently large to make crop production fairly certain, yet on account of the unequal distribution of the rainfall and the high evaporation the effect of the precipitation is much lessened. The mean annual evaporation from a free water surface, as measured at the experiment farm for the 7-year period specified, is 65.88 inches.

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[1] From January, 1910, to October, 1911, the experiments here reported were under the direct supervision of Mr. S. H. Hastings, superintendent of the San Antonio Experiment Farm. Mr. C. R. Letteer has had direct charge of the work since October, 1911.

The winters are mild, yet periods of cold weather or "northers" are not infrequent during the winter season. The thermometer seldom registers a temperature below 15° F. in winter, and consequently plant growth continues practically throughout the year.

SOIL CONDITIONS.

The San Antonio Experiment Farm is located on what is called locally black "hog-wallow land." This local name is due to the fact that the soil, when drying, shrinks and opens long, wide cracks, and the filling of these cracks with loose surface soil results in irregular depressions, which resemble hog wallows. The soil is a black clay loam, having a rather small proportion of sand and becoming very sticky when wet. It is classified by the United States Bureau of Soils[1] as Houston black clay loam and San Antonio clay loam.

The first 3 feet of soil is fairly uniform in character and is underlain with a white gravelly material which is rich in lime. This underlying gravel has a relatively low moisture-holding capacity, while the surface soil has a high moisture-holding capacity, averaging from 25 to 30 per cent. When wet, the soil has a tendency to pack and become impervious, so that during torrential rains the loss of water from run-off is high. The soil is rich in mineral plant food and produces abundant crops when supplied with sufficient moisture.

FALLOWING EXPERIMENTS.

In 1910 experiments were inaugurated for the purpose of studying the effect of producing a crop only on alternate years, as compared with producing a crop every year on the same land. The crops of 1910 were grown on land which had not been previously fallowed, so that the results for that year are not considered here. The results here presented are from the years 1911, 1912, and 1913.

The crops used in these experiments were corn, cotton, and winter oats. For this purpose six ¼-acre plats were used, as follows: Plats A4–1 and A4–2 were used alternately for cotton, one plat being cropped and the other fallowed each year. In a similar way plats A4–3 and A4–4 were used for corn and A4–5 and A4–6 for winter oats. For purposes of comparison with these biennially cropped plats, use has been made of results obtained from three plats which are part of another experiment. These three plats are cropped each year and are given the same tillage treatment as the alternately cropped plats, except that the fallow period is 12 months shorter. The plats that are cropped annually have been under test since 1909, when the large rotation and tillage experiment of which they are a part was started. The plats which are continuously cropped are as follows: B5–1, corn; B5–3, cotton; and B5–8, oats. The plats are each 264 feet long and 41.25 feet wide, and they are separated by alleys 4¾ feet wide.

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[1] Field Operations of the Bureau of Soils, 1904.

TREATMENT OF THE PLATS.

Figure 1 shows graphically the cropping system practiced on the plats considered in this report, from the time the biennial cropping experiments were started until the close of the year 1913.

The winter oats were seeded early in November and harvested in May, the corn was planted the latter part of February and harvested in July, and the cotton was planted early in April and the harvest completed in October.

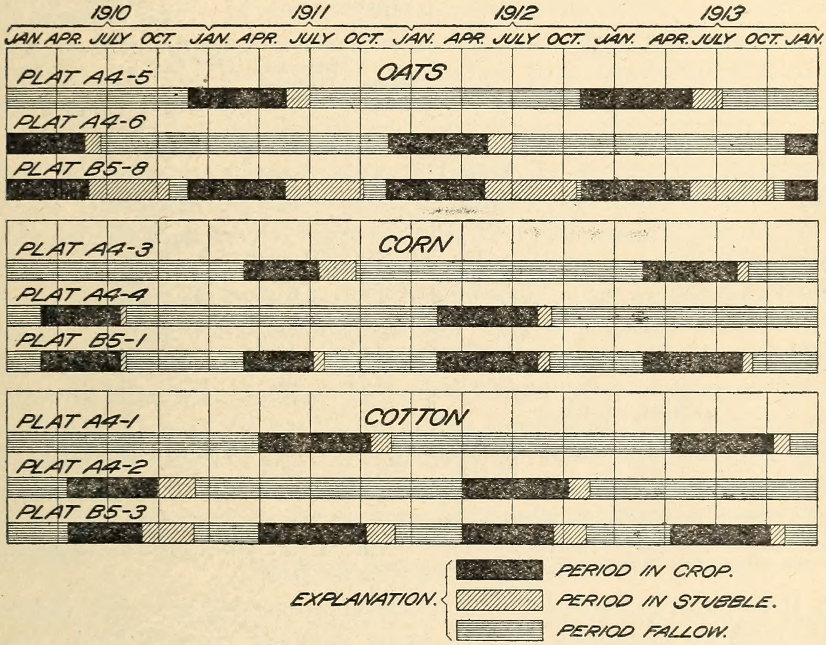

FIG. 1.—Diagram showing the cropping system practiced on the plats where biennial cropping has been tested in comparison with continuous cropping at the San Antonio Experiment Farm.

In all cases except plat B5–8 (oats cropped annually) the plats were plowed about 8 inches deep as soon as practicable after the crop was removed. Plat B5–8 was left unplowed until just before planting time. After plowing, the plats were harrowed after the first heavy rain came, to soften the clods. They were then harrowed or disked after each rain of consequence and also whenever it was necessary to keep them clear of weed growth and to maintain a soil mulch. For the most part the spike-tooth harrow was sufficient to maintain an adequate mulch throughout the greater part of the fallow period.

YIELDS OBTAINED.

Table I gives the yields of various crops from the plats cropped biennially, as compared with the yields of the same crops on plats cropped annually, and the average yields of the various crops from all plats planted to each crop in the rotation experiments. The average yields are obtained by considering all of the plats in the rotation experiments and should be fairly representative of results from good farming in that region.

TABLE I.—*Crop yields from plats cropped biennially, as compared with plats cropped annually and with all plats used for these crops in the rotation experiments.*[1]

Year and crop.	Biennial cropping.		Annual cropping.	Average of all rotation plats.	
	Actual.	Percentage of annual cropping.		Yield.	Number of plats averaged.
1911.					
Corn..........bushels..	3.2	59.2	5.4	10.6	29
Cotton..........pounds..	318.0	71.3	446.0	483.0	25
Oats..........bushels..	10.1	160.5	6.3	8.5	11
1912.					
Corn..........bushels..	24.7	92.9	26.6	34.1	26
Cotton..........pounds..	448.0	94.6	474.0	621.5	25
Oats..........bushels..	37.0	181.5	20.4	26.75	10
1913.					
Corn..........bushels..	30.7	92.8	33.1	34.9	21
Cotton..........pounds..	350.0	53.9	508.0	560.1	30
Oats..........bushels..	38.0	369.0	10.3	11.7	9
AVERAGE, 1911–1913.					
Corn..........bushels..	19.5	89.9	21.7	26.5	....
Cotton..........pounds..	372.0	78.2	476.0	554.9	....
Oats..........bushels..	28.4	231.0	12.3	15.7	....

[1] The rotation experiments are conducted on 82 quarter-acre plats. They include continuous cropping, biennial cropping, and 2-year, 3-year, and 4-year rotations, combined with various tillage methods, manuring, and green manuring. In general, it would be expected that the average yields in these experiments would be larger than those obtained from the continuously cropped plats.

It is shown in Table I that in no instance has cotton or corn yielded as much on biennially cropped as on annually cropped land. The average yields of cotton and corn on all the rotation plats have been higher than those secured from either biennial cropping or annual cropping, indicating that neither fallowing nor continuous cropping for corn and cotton is to be recommended as a general practice under San Antonio conditions.

On the other hand, winter oats on land biennially cropped have consistently yielded higher than where planted annually on the same land and higher than the average from all oat plats in the rotation experiments.

VEGETATIVE GROWTH OF CROPS ON FALLOWED LAND.

It has been observed during the past two years that during the greater part of the growing period oats made a less rank growth on the fallowed plat than on the plats in the rotation experiments.

This comparatively light vegetative growth appears to have been favorable to the production of grain. In 1912 and 1913, especially the latter season, oats on the rotation plats lodged badly, owing to excessive vegetative growth. It has been found at San Antonio that any treatment which has a tendency to retard the early vegetative growth of the oat plant results in increased yields of grain. An instance substantiating this statement is afforded by the unfavorable results from manuring on land planted to oats to be harvested for grain. In a 4-year test with oats, manuring has noticeably decreased the yield of grain in two out of the four years, while in the other two years the yields were practically the same as those obtained from unmanured land. It appears, therefore, that the increase in yield of oats on fallowed land has not been due to the fact that conditions were more favorable to growth, but rather to a depressing effect on the vegetative growth.

Crops grown on fallowed land have invariably shown irregular and slow early development as compared with the same crops on other plats. The corn and cotton on the fallowed plats have been noticeably smaller than on the other plats in the rotation experiments, and the plants have lacked uniformity in size and appearance. Observations on other plats of the experiment farm where cotton has been grown on fallowed land corroborate this conclusion. While the differences with oats have not been so marked, in 1913 the oats on fallowed land were smaller and made slower growth than on land continuously cropped or having other treatments. On account of the difficulty with the lodging of grain crops, as already indicated, the depressing effect of fallowing on the growth of the plants results in high yields of oats, while it has the opposite effect on corn and cotton.

SOIL-MOISTURE STUDIES.

Soil-moisture determinations have been made on the fallowed plats considered in this report and also on the continuously cropped plats devoted to the same crops. Samples have been taken monthly or oftener during the summer throughout the three years. A standard soil tube was used for securing the samples. At each sampling two cores were taken from different parts of the plat, corresponding foot-sections being composited to a single sample. Thus either three or six samples were secured from each plat, depending upon the depth to which the sampling was done. In most cases samples were taken to a depth of 6 feet.

In figures 2, 3, and 4 the diagram at the top shows the crop, stubble, and fallow periods for each plat considered in this report, and the curves below show the moisture content of the different plats at the time the moisture determinations were made during the four years from 1910 to 1913, inclusive.

Moisture determinations have been made on each of the plats at planting time and just before or just after harvest, to determine the amount of moisture present at planting time and the amount of stored moisture used from each plat.

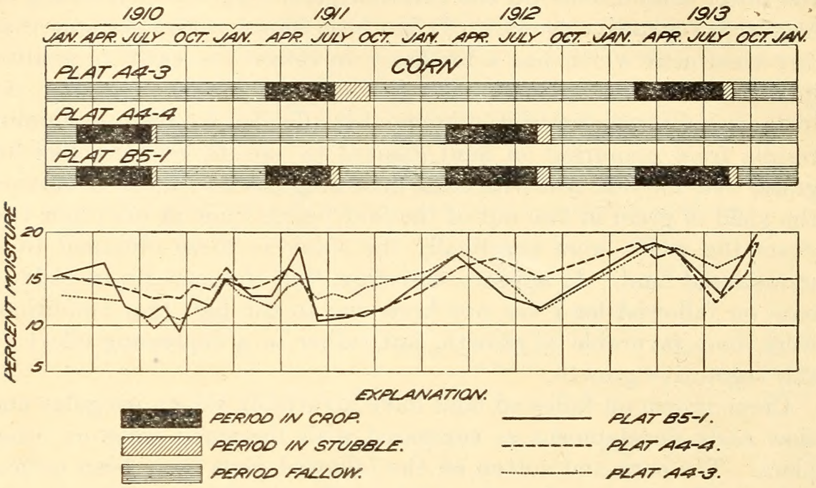

FIG. 2.—Diagram showing the average moisture content of the soil on plat B5-1, which was cropped annually to corn, and on plats A4-3 and A4-4, which were cropped biennially to corn, at the San Antonio Experiment Farm, January, 1910, to October, 1913. On each sampling date all the plats were sampled to a uniform depth, in most cases 6 feet, but in some instances 3 feet.

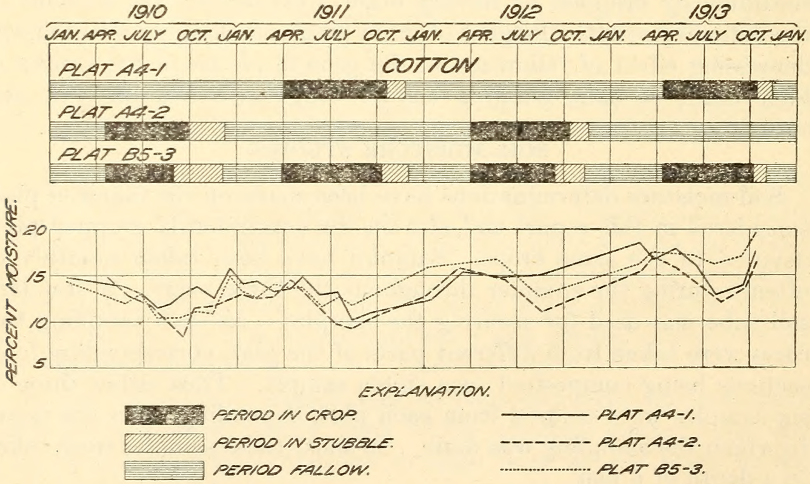

FIG. 3.—Diagram showing the average moisture content of the soil on plat B5-3, which was cropped annually to cotton, and on plats A4-1 and A4-2, which were cropped biennially to cotton, at the San Antonio Experiment Farm, January, 1910, to October, 1913. On each sampling date all the plats were sampled to a uniform depth, in most cases 6 feet, but in some instances 3 feet.

By observing carefully the curves showing the moisture content in the various plats it will be seen that the moisture content of the plats of corn (fig. 2) and cotton (fig. 3) was generally highest in the spring at about planting time for these crops; that there was a general decline in the moisture content of the cropped plats until harvest and also a slight decline in the moisture content of fallowed plats; and that there was only a slight difference in the moisture content of the fallowed and continuously cropped plats at either planting or harvest time, the tendency being for the curves to coincide at these periods.

The moisture content of the oat plats (fig. 4) was generally highest during the months of January and February and lowest in June, at about harvest time. At planting time for oats in the autumns of 1910 and 1912 the moisture content of the fallowed plat was somewhat higher than that of the continuously cropped plat, and in 1911 it was nearly the same. At harvest time in 1911 and also in 1912 the moisture content of the fallowed plat was somewhat lower than that of the continuously cropped plat, and in 1913 the moisture content of both plats was about the same.

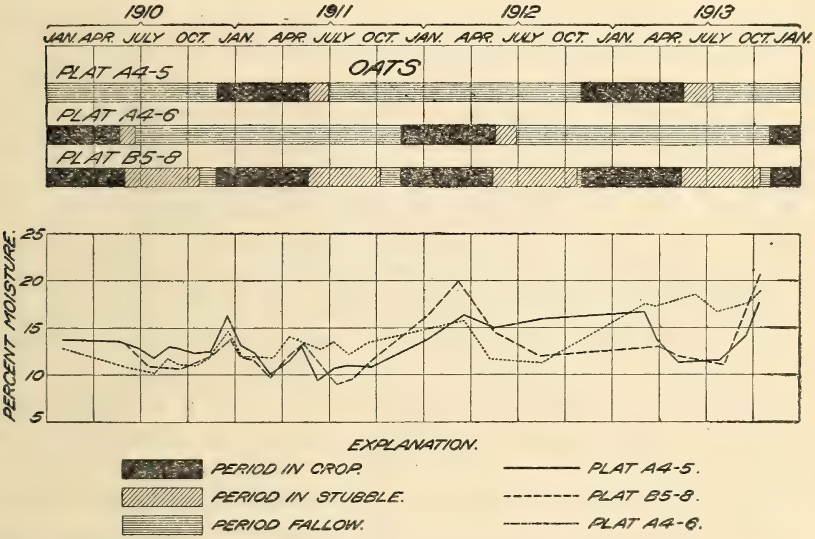

FIG. 4.—Diagram showing the average moisture content of the soil on plat B5-8, which was cropped annually to oats, and on plats A4-5 and A4-6, which were cropped biennially to oats, at the San Antonio Experiment Farm, January, 1910, to October, 1913. On each sampling date all the plats were sampled to a uniform depth, in most cases 6 feet, but in some instances 3 feet.

It appears from this that fallowing resulted in a higher moisture content in the fall at planting time for oats, and that when the land remained fallow until time for planting corn and cotton, fallowing did not store any appreciable quantity of moisture in the soil in excess of that stored in land continuously cropped, plowed in the fall, and left fallow during the winter.

For the most part the curves show only slight variations in the amount of moisture present in the fallowed and continuously cropped plats during the period when crops were on the land. There was a somewhat higher moisture content in the soil of the fallow plats at the time when crops were growing on the other plats; but, as already stated, the difference generally disappeared by the next planting time.

RUN-OFF FROM FALLOWED PLATS.

The uniformity in soil-moisture content at planting time, already noted, is probably accounted for by the higher loss by run-off from fallow plats than from those which were cropped every year. During the years covered by this report the precipitation during the winter and early spring was comparatively heavy. Consequently, so far as the rainfall during the winter and spring immediately preceding corn and cotton planting was concerned, land cropped each year and plowed as soon as possible after the removal of the crop had the same opportunity to store moisture as fallowed land had during the same period. Even though the fallowed land contained a larger amount of moisture at the time of seeding oats in the fall, a larger amount of run-off from the fallowed plats during the winter would result in approximately uniform moisture conditions in all the plats at the time of planting corn and cotton the following spring. That there is a difference in the run-off from the different plats is proved by the results of determinations shown in Table II.

On February 16, 1912, three days after a rain of 3.3 inches, soil samples were taken on one plat of oats and on five fallow plats where the length of time since plowing varied from 3 to 18 months. Table II shows the moisture content at the last sampling before the rain and again three days after the rain, together with the increase in moisture, the run-off in inches, and the percentage of rainfall lost by run-off.

On February 26, samples were again taken on the same plats after a 2-days' rain of 2.9 inches. The results are also given in Table II.

TABLE II.—*Absorption and run-off from rains in February, 1912, San Antonio Experiment Farm.*

Plat No.	Fallow period or crop.	Samples taken on Feb. 16, three days after a 3.3-inch rain.					
		Average moisture content in 3 feet.		Increase.		Run-off.	
		5 days before rain.	3 days after rain.	Per cent.	Inches.	Inches.	Percentage of rainfall.
		Per cent.	*Per cent.*				
A4-1	3 months	15.8	19.9	4.1	1.92	1.38	41.8
A4-2	15 months	19.1	21.6	2.5	1.17	2.13	64.5
A4-3	5 months	17.2	19.8	2.6	1.22	2.08	63.0
A4-4	18 months	20.0	23.0	3.0	1.40	1.90	57.5
A4-5	6 months	18.4	20.6	2.2	1.03	2.27	68.8
A4-6	Oats	18.1	22.3	4.2	1.96	1.34	40.6

Table II.—*Absorption and run-off from rains in February, 1912, San Antonio Experiment Farm*—Continued.

Plat No.	Fallow period or crop.	Samples taken on Feb. 26, one day after a 2.9-inch rain, when the soil was already wet.					
		Average moisture content in 6 feet.		Increase.		Run-off.	
		7 days before rain.	1 day after rain.	Per cent.	Inches.	Inches.	Percentage of rainfall.
		Per cent.	*Per cent.*				
A4-1	3 months	15.2	16.6	1.4	1.3	1.61	55.3
A4-2	15 months	16.8	17.2	.4	.37	2.54	87.1
A4-3	5 months	15.3	16.8	1.5	1.4	1.51	51.7
A4-4	18 months	16.7	17.8	1.1	1.03	1.88	64.6
A4-5	6 months	15.5	16.2	.7	.66	2.25	77.3
A4-6	Oats	16.3	18.4	2.1	1.96	.95	32.6

Table II shows that the run-off from land that had been fallow for several months was greater than from land plowed a comparatively short time before the heavy rains. The proportion of run-off from the second rain was somewhat greater than that following the first rain, and the difference in run-off from plats fallowed for a short time and from those which had been fallow for a longer time was more marked. The run-off from the oat plat was materially less following both rains than that from any of the fallow plats.

ECONOMIC CONSIDERATIONS.

The question of whether it is desirable to make a practice of biennial cropping for certain crops must be considered from two standpoints: (1) The effect upon the crop and (2) the cost of production as compared with annual cropping. It must be remembered that in the first case only one crop is grown in two years and that fixed costs, such as the interest on the investment in land for two years, must be charged against one crop. Under the conditions at San Antonio, where plant growth continues practically the entire year, making necessary the cultivation of the fallow to kill weeds and maintain a mulch, the expense of fallowing is nearly, if not quite, as much as that of growing a crop on the land. Other items, such as the depletion of the humus and the possible ultimate effect on fertility, are matters deserving consideration in connection with the practice of biennial cropping. It must be concluded, then, that even though biennial cropping gave increased yields of winter oats at San Antonio it is not necessarily desirable as a farm practice in growing that crop there. In other words, the results of these experiments indicate that biennial cropping is not to be recommended for the San Antonio region, at least for cotton, corn, and oats.

SUMMARY.

(1) Tests of biennial cropping in comparison with annual cropping have been carried on at the San Antonio Experiment Farm for three years.

(2) The yields of corn and cotton have been less on biennially cropped land than on annually cropped land. The yields of winter oats have been somewhat larger on the biennially cropped land.

(3) Soil-moisture studies made in connection with these tests do not show any important differences in the amount of soil moisture present in fallowed land and in continuously cropped land at planting and harvest time for corn and cotton. In the plats used for oats there was more moisture present at planting and less at harvest time on the biennially cropped land than on the annually cropped land. In other words, the oats grown biennially used more water and made less vegetative growth, but gave larger yields.

(4) Observations made after heavy rains show that in most cases the proportion of run-off from heavy rains was greater on land which had been fallow for several months than on land which had been fallow for a comparatively short time. The run-off from an oat plat was less than from any of the fallow plats.

(5) Considering both crop yields and cost of production, the results of these experiments indicate that biennial cropping, at least for corn, cotton, and oats, is not to be recommended for the San Antonio region.

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